(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 252 739 A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 87306075.0

(22) Date of filing: 09.07.87

(51) Int. Cl.⁴: H 01 L 21/68

(30) Priority: 09.07.86 JP 161682/86
26.02.87 JP 43744/87

(43) Date of publication of application:
13.01.88 Bulletin 88/02

(84) Designated Contracting States: DE FR GB NL

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(54) Adhesive sheets for sticking wafers thereto.

(57) according to the present invention are adhesive sheets which are applied to the face side of wafers having formed patterns thereon when the reverse side of said wafers are subjected to grinding treatment, characterized in that the adhesive sheets comprise a base and a water-swelling adhesive coated thereon as an adhesive layer.

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Bundesdruckerei Berlin

Description

ADHESIVE SHEETS FOR STICKING WAFERS THERETO

FIELD OF THE INVENTION

This invention relates to adhesive sheets which are applied to the face side of semiconductor wafers in the course of grinding the reverse side of the semiconductor wafers having formed patterns on the face side thereof, and more particularly to adhesive sheets for sticking wafers thereto which are used when the reverse side of semiconductor wafers having formed patterns by etching or the like technique on the face side thereof are ground.

BACKGROUND OF THE INVENTION

On the face side of wafers of semiconductors such as silicon, gallium-arsenic, etc., there are formed patterns by the etching or lift-off technique. Subsequently, an adhesive sheet is applied to the face side of the wafers having formed patterns thereon and usually the thus applied wafers are subjected, as they are, on the reverse side thereof to grinding treatment by means of a grinder or the like. The purpose of subjecting the reverse side of wafers having formed patterns on the face side thereof to grinding treatment is firstly to remove a film of oxide from said reverse side as the oxide film is sometimes formed thereon during the etching step, and secondly to adjust the pattern-formed wafers in thickness to a desired level.

In this connection, the grinding treatment of the reverse side of wafers having formed patterns on the face side thereof is carried out while washing said reverse side with purified water in order to remove the resulting grindings as well as heat generated at the time of grinding. Accordingly, adhesive sheets applied to the face side of wafers in the grinding treatment of the reverse side of the wafers to protect the patterns formed on the face side thereof must have water resistance. For this reason, solvent-type acrylic adhesives have widely been used in adhesive sheets used for the purpose intended.

After the completion of the grinding treatment of the reverse side of wafers conducted in the manner now described, the adhesive sheets applied are stripped off therefrom. In that case, however, there were observed some cases wherein acrylic adhesives or the like of the adhesive sheets used remained attached to the face side of the wafers having formed patterns thereon. On that account, the adhesives thus attached to the face side of the wafers had to be removed therefrom.

Removal of the acrylic adhesives or the like attached to the face side of wafers has been carried out hitherto by washing said face side with chlorine-containing type organic solvents such as Trichlene, followed by cleaning with purified water. Because of the risk of exerting adverse effects on the human body, however, chlorine-containing solvents such as Trichlene used for washing the face side of wafers are desirably not used. Furthermore, the above-mentioned process of washing the face side of wafers has been found to be a time-consuming job since the process comprises two steps, the first one of which is the washing of said face side with organic solvents such as Trichlene, and the second is the cleaning of the washed face side with purified water. Under these circumstances, it would be advantageous for the washing process of the face side of wafers to be completed in a single step without any danger to the human body by using adhesives attached to the face side of wafers which can be removed by cleaning with purified water in place of chlorine-containing type organic solvents. As mentioned previously, however, the grinding process of the reverse side of wafers is carried out while washing said reverse side with purified water. If, therefore, water-soluble adhesives widely used heretofore as adhesives for adhesive sheets are used in the adhesive sheets as originally intended herein, it follows, as a natural consequence, that the problem is created that the water-soluble adhesive dissolves in the purified water during the above-mentioned grinding process and the resulting grindings present in said purified water enter into the space formed between the face side of wafers and adhesive sheet, thereby destroying the patterns formed on said face side.

OBJECT OF THE INVENTION

The present invention is intended to solve at a single stroke such problems associated with the prior art as mentioned above, and its object is to provide adhesive sheets which are to be applied to the face side of wafers having formed patterns thereon when the reverse side of said wafers is subjected to grinding treatment, and which are so designed that the adhesive of the adhesive sheets, when it remains attached to the face side of wafers after the completion of the grinding treatment, can be removed by cleaning with water without using organic solvents such as Trichlene; accordingly there is no danger to the human body and, moreover, removal of the adhesive, which is occasionally attached to the face side of wafers, can be effected by a single step.

SUMMARY OF THE INVENTION

The adhesive sheets for sticking wafers thereto according to the present invention are adhesive sheets which are applied to the face side of wafers having formed patterns thereon when the reverse side of said wafers are subjected to grinding treatment, characterized in that the adhesive sheets comprise a base sheet and a water-swelling adhesive coated thereon as an adhesive layer.

In the case of the adhesive sheets of the invention as mentioned above, a water-swelling adhesive is applied

as an adhesive layer to the base of said adhesive sheet and, therefore, even when the adhesive remains attached to the face side of wafers after stripping off said adhesive sheets therefrom subsequent to the completion of the grinding treatment of the reverse side of wafers, the attached adhesive can be removed therefrom by cleaning with water without using organic solvents such as Trichlene. Accordingly, there is no possibility to exert adverse effects on the human body and, moreover, the adhesive attached to the face side of wafers can be removed therefrom by a single step.

DETAILED DESCRIPTION OF THE INVENTION

The adhesive sheets for sticking wafers thereto (hereinafter called "the wafer-sticking adhesive sheets" for brevity's sake) obtained in accordance with the present invention are illustrated below in more detail.

The wafer-sticking adhesive sheet 1 of the invention comprises a base 2 and an adhesive layer 3 formed by applying an adhesive to on the surface of said base 2, as schematically illustrated in the accompanying Fig. 1. In order to protect this adhesive layer 3 before the adhesive sheet 1 is used, it is preferable to apply temporarily a release sheet 4 to the face side of the adhesive layer 3 in the manner as shown in Fig. 2.

The wafer-sticking adhesive sheets of the invention can be in any forms such as tape, labels and the like. Materials excellent in water resistance as well as in heat resistance, particularly films of synthetic resins, are suitable as those for the base 2.

Examples of the materials usable as the base 2 include films of synthetic resins such as polyethylene, polypropylene, polyvinyl chloride, polyethylene terephthalate, polybutylene terephthalate, polybutene, polybutadiene, polyurethane, polymethyl pentene and ethylene-vinyl acetate copolymer. Furthermore, cross-linked polyolefin or ethylene-methacrylic acid copolymer film can also be used as the base 2.

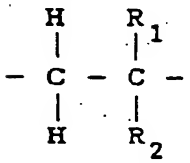
In a preferred embodiment of the present invention, a water-swelling adhesive is applied as the adhesive layer 3 to the base as exemplified above.

The water-swelling adhesive as used herein is preferably an adhesive which essentially consists of a copolymer having as its recurring structural units an unsaturated carboxylic acid-containing monomer and acrylic ester type monomer, in which the copolymeric units are mutually interlocked or cross-linked, said adhesive undergoing finite swelling on contact with water. Where it is necessary to vary water-solubility or adhesion characteristics of the adhesive used from the practical point of view, hydrophilic plasticizers or hydrophilic epoxy compounds commonly adopted for the purpose intended may be used in combination with the above-mentioned water-swelling adhesive.

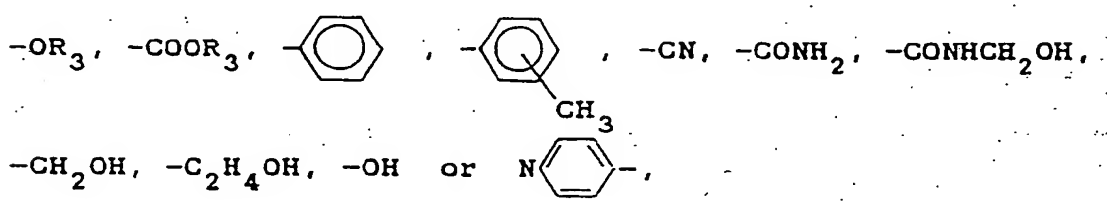
Usable as the water-swelling adhesive in the present invention are those disclosed, for example, in Japanese Patent Publication No. 23294/1974.

That is, the disclosed adhesives are composed of (A) one or two or more nonionic surface active agents having polyoxyethylene groups as their hydrophilic components, and (B) one or two or more copolymers composed of 40-99 mol% of one or two or more recurring structural units represented by the following formula (I) and 60-1 mol% of one or two or more recurring structural units represented by the following formula (II), said copolymer or copolymers being cross-linked, if necessary, with a crosslinker such as zinc acetate or magnesium chloride which reacts with the carboxyl group of the component (B). In that case, alkaline compounds such as potassium hydroxide may be allowed to coexist with the crosslinker at the time of cross-linking.

Formula (I)



wherein R_1 is hydrogen, chlorine or lower alkyl and R_2 is hydrogen, chlorine, lower alkyl or the group of $-OCOR_3$,

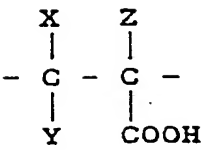


$-OR_3$, $-COOR_3$, , , $-CN$, $-CONH_2$, $-CONHCH_2OH$,

$-CH_2OH$, $-C_2H_4OH$, $-OH$ or $-$,

in which R_3 is alkyl of 1-8 carbon atoms (lower alkyl groups as referred to herein are preferably C_{1-4}).

Formula (II)

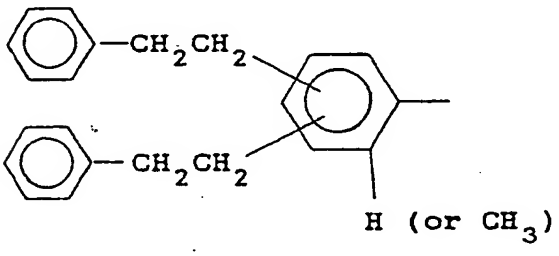


wherein X, Y and Z, which may be the same or different, are each hydrogen, chlorine, lower alkyl or the group of $-COOR_4$, -COOH, $-CH_2COOH$ or $-CH_2COOR_4$, in which R_4 is alkyl of 1-4 carbon atoms.

Usable as the component (A), a nonionic surface active agent having the polyoxyethylene group as its hydrophilic component, are those having the following formulas as exemplified below.

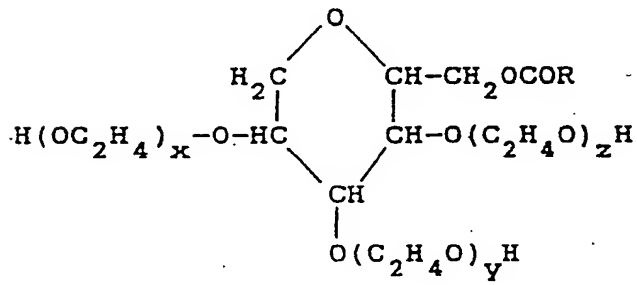
(i) $OH(C_2H_4O)_a(C_3H_6O)_b(C_2H_4O)_cH$ wherein a, b and c are each an integer of 20-80.

(ii) $RA(C_2H_4O)_eH$ wherein R is alkyl of 6-8 carbon atoms, alkylphenyl having alkyl of 4-20 carbon atoms or the group



A is oxygen, sulfur or the group of -COO, -CONH, $CON(C_2H_4O)_eH$, PO_4H or $PO_4(C_2H_4O)_eH$, and the symbols e, which may be the same or different, each represent an integer of 2-80.

(iii)



wherein R is alkyl of 6-18 carbon atoms, and x, y and z are each an integer of 2-40.

Examples of the above-mentioned nonionic surface active agent used as the component (A) include, for example, polyethylene glycol nonylphenyl ether, polyethylene glycol sorbitan monooleyl ester, polyethylene glycol lauryl ether, block copolymers of polyethylene glycol and polypropylene glycol, polyethylene glycol laurylphenyl ether and polyethylene glycol t-butylphenyl ether.

The recurring structural units represented by the aforementioned formula (I) in the component (B) are introduced from such monomers as, for example, vinyl esters such as vinyl acetate, acrylic esters such as ethyl acrylate, methacrylic esters such as ethyl methacrylate, ethylene, styrene, methyl vinyl ether, vinyl chloride and acrylonitrile. The recurring structural units represented by the aforementioned formula (II) in the component (B) are introduced from monomers having carboxyl groups, for example, acrylic acid, methacrylic acid, crotonic acid, itaconic acid, maleic acid, fumaric acid, aconitic acid, monoalkylmaleic acid, monoalkylfumaric acid and monoalkylitaconic acid.

The above-mentioned components (A) and (B) must be compatible with each other and, moreover, the adhesives obtained therefrom must be water-swelling. On that account, a quantitative relationship between the components (A) and (B) is stipulated.

Depending on circumstances, glycidyl ether type epoxy compounds can also be used together with the above-mentioned components (A) and (B).

As the water-swelling adhesive used in the present invention, there can also be used such adhesives as disclosed in Japanese Laid-Open-to-Public Publn. No. 157162/1984.

That is, the disclosed adhesives are composed essentially of such components as (A) a water-soluble polymer and (B) a (meth)acrylic ester monomer which, when polymerized, gives a water-swelling polymer.

Concretely, the above-mentioned component (A) is derived from a (meth)acrylic ester monomer represented by the formula

$$CH_2 = CR^1 - C(=O) + O-R^2 \rightarrow_n O - R^3$$

wherein R^1 is hydrogen or methyl, R^2 is alkylene of 2-4 carbon atoms, R^3 is alkyl of 1 or more carbon atoms, and n is an integer of 1 or more, (meth) acrylic acid, (meth) acrylic ester, Vinylpyrrolidone, acrylamide, dimethylaminoethyl (meth) acrylate, diethylaminoethyl (meth) acrylate, or vinyl methyl ether. According to circumstances, usable as the water-soluble polymer of (A) mentioned above are polymers obtained by copolymerizing such a monomer as mentioned above with acrylic ester, vinyl acetate or styrene in an amount of up to 30 parts by weight.

As the component (B) mentioned above, there are used, for example, (meth)acrylic ester monomers, dimethylaminoethyl(meth)acrylates and diethylaminoethyl(meth)acrylates.

Further, usable as the water-swelling adhesives in the present invention are such adhesives as disclosed in Japanese Laid-Open-to-Public Publn. No. 70077/1981.

That is, the disclosed water-swelling adhesives are composed essentially of such components as (A) a salt of a copolymer obtained by neutralizing the carboxyl group in a copolymer comprising 10-40 mol% of a carboxyl-containing monomer, 60-90 mol% of (meth)acrylic alkyl ester having alkyl of 4 or more carbon atoms and 0-20 mol% of vinyl monomer other than the above-mentioned monomers and (B) a hydrophilic compound represented by the formula $R_1 O(R_2 O)_n R_3$ wherein R_1 is alkyl of 1-4 carbon atoms, R_2 is alkylene of 2-4 carbon atoms, R_3 is hydrogen, alkyl of 1-4 carbon atoms or acetyl, and n is an integer of 1-6. Where the adhesive sheet 1 having coated thereon such adhesive as mentioned above to form an adhesive layer has been applied to the pattern-formed face side of said wafer A and the reverse side of said wafer A is subjected to grinding treatment while spraying purified water thereover, swelling equilibrium is established after absorption of water and an effect of preventing the sprayed water from permeating into the adhesive layer up to the pattern portions is obtained. By virtue of this effect, no wafer grindings present in the purified water being sprayed enter in between the pattern-formed face side of the wafer A and adhesive sheet 1, thus the patterns formed on the face side of the wafer A can sufficiently be protected.

In the accompanying drawings, Figs. 1 and 2 are sectional views of the adhesive sheet of the present invention, and Figs. 3 and 4 are explanatory diagrams showing the grinding of the reverse side of wafer, wherein:

1...Adhesive Sheet
2...Base
3...Adhesive layer
A...Wafer
B...Remaining adhesive
C...Wafer

A method for the application of the adhesive sheet 1 of the present invention is illustrated hereinafter.

Where a release sheet 4 is provided on the top of an adhesive sheet 1 for sticking wafers according to the present invention, said release sheet 4 is first removed therefrom, and a wafer A, the reverse side of which is to be subjected later to grinding treatment, is stuck to an adhesive layer 3. In that case, the wafer A is stuck to the adhesive layer 3 so that the face side of said wafer having formed patterns 5 thereon is in contact with said adhesive layer 3.

At a stage as mentioned above, the reverse side 6 of the wafer A is ground by means of a grinder 7, thereby removing an oxide film formed thereon and, at the same time, adjusting the wafer A in thickness to a desired level. In that case, the resulting wafer grindings are washed away by spraying purified water over the wafer A and, at the same time, heat generated at the time of grinding is removed.

After the completion of the grinding, the adhesive sheet 1 is then stripped off from the wafer A. In that case, a water-soluble adhesive or the like sometimes attaches to the face side of the wafer A having formed thereon the patterns 5. The attached adhesives 5 have a sufficient water-solubility and hence can be simply washed away with the purified water C.

In this manner, since the water-swelling adhesives are used to form the adhesive layer in the adhesive sheets for sticking wafers thereto of the present invention, even when the adhesives attach to the face side of wafers, the attached adhesives can be removed therefrom by cleaning with purified water without using organic solvents such as Trichlene, accordingly there is no risk at all of exerting adverse effects on the human body. In accordance with the present invention, moreover, it is sufficient to clean the face side of wafers, to which the adhesives attach, with the purified water, thus the cleaning operation can be carried out by a single step, whereas in the prior art adhesive sheets used for the same purpose, there was need of two steps for the cleaning operation wherein the face side of wafers, to which the adhesives were attached, was washed with organic solvents such as Trichlene, followed by cleaning with purified water.

Furthermore, in the adhesive sheet 1 for sticking wafers thereto of the present invention, there is no possibility that wafer grindings enter in between the face side of wafers and adhesive sheet at the time of grinding the reverse side of the wafer A because the adhesive sheet 1 having a sufficient adhesion force is applied to the face side of the wafer A, and the wafer grindings cannot enter in between the face side of wafers

and adhesive sheet and thereby destroy the patterns formed on the face side of wafers.

EFFECT OF THE INVENTION

The wafer-sticking adhesive sheets of the present invention are adhesive sheets to be applied to the face side of wafers when the reverse side of said wafers is subjected to grinding treatment, and are coated on the surface thereof with water-swelling adhesives to form an adhesive layer. Therefore, when the adhesive sheet is stripped off from the face side of wafers after the completion of the grinding treatment of the reverse side of said wafers, the adhesive which remains attached, if any, to the face side of the wafers can be removed therefrom by cleaning with water without using organic solvents such as Trichlene. Accordingly, there is no risk of exerting adverse effects on the human body and, moreover, the adhesive, which is occasionally attached to the face side of wafers can be removed by a single step.

EXAMPLE 1

On a polyester film of 50 μm in thickness was coated at a coating weight (dry basis) of 40 g/m^2 an acrylic type water-swelling adhesive composed of (i) a copolymer of ethyl acrylate, vinyl acetate and methacrylic acid and (ii) polyethylene glycol lauryl ether, said copolymer having been cross-linked with zinc acetate in the presence of potassium hydroxide. Thus, there was obtained an adhesive sheet having an adhesion force of 90 g/25 mm at 180° as measured according to JISZ-0237.

The adhesive surface of the thus obtained adhesive sheet was applied by means of a press roll with a load of 1 kg to the face side of a wafer having formed patterns thereon. This test specimen was fixed accurately to a grinding apparatus so that the reverse side of the wafer is turned upward, and said reverse side was ground for 5 minutes under a water pressure of 30 kg/cm^2 with water-spraying.

Thereafter, the adhesive sheet was stripped off from the wafer, and said wafer was observed on the face side thereof, after cleaning and drying, by means of an electron microscope.

The results obtained are shown in Table 1.

COMPARATIVE EXAMPLE 1

Following the same procedure as described in Example 1, a solvent type acrylic adhesive (composed of 100 parts by weight of a copolymer of n-butyl acrylate, vinyl acetate and acrylic acid, having a molecular weight of 300,000, and 10 parts by weight of an isocyanate curing agent) was applied to the polyester film to obtain an adhesive sheet having likewise an adhesion force of 85 g/25 mm at 180°.

The adhesive sheet thus obtained was applied to the face side of the wafer in the same manner as in Example 1 and the same observation was conducted.

The results are shown in Table 1.

Table 1

	Permeation into interface of water	Adhesive remaining on the face side of wafer *		
		After stripping adhesive sheet	After cleaning with purified water	After washing with Trichlene
Example 1	None	Slightly observed	None	
Comparative Example 1	None	Slightly observed	Slightly observed	None

* Electron microscope Magnification 5000 times

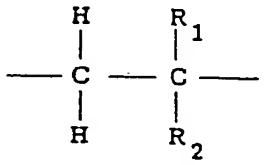
Claims

1. An adhesive sheet for sticking wafers thereto, which is applied to the face side of wafers having formed patterns thereon when the reverse side of said wafers are subjected to grinding treatment, characterised in that the adhesive sheet comprises a base sheet and a water-swelling adhesive coated thereon as an adhesive layer.

2. The adhesive sheet as claimed in claim 1 wherein the base is polyethylene, polypropylene, polyvinyl chloride, polyethylene terephthalate, polybutylene terephthalate, polybutene, polybutadlene, polyurethane, polymethyl pentene, ethylene-vinyl acetate copolymer, cross-linked polyolefin or ethylene-methacrylic acid copolymer.

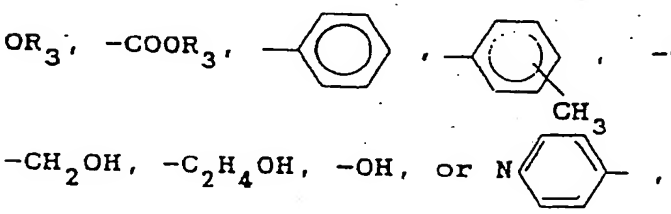
3. The adhesive sheet as claimed in claim 1 wherein the water-swelling adhesive undergoes finite swelling on contact with water.

4. The adhesive sheet as claimed in claim 1 wherein the water-swelling adhesive comprising (A) one or two or more nonionic surface active agents having ethylene oxide groups as their hydrophilic components, and (B) one or two or more copolymers composed of 40-99mol% of one or two or more recurring structural units represented by the following formula (I) and 60-1mol% of one or two or more recurring structural units represented by the following formula (II), said copolymer or copolymers being cross-linked, if necessary, with a crosslinker, such as zinc acetate or magnesium chloride which reacts with the carboxyl group of the component (B).

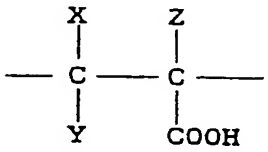


(I)

wherein R_1 is hydrogen, chlorine or lower alkyl and R_2 is hydrogen, chlorine, lower alkyl or the group of $-OCOR_3$,



in which R_3 is alkyl of 1-8 carbon atoms.



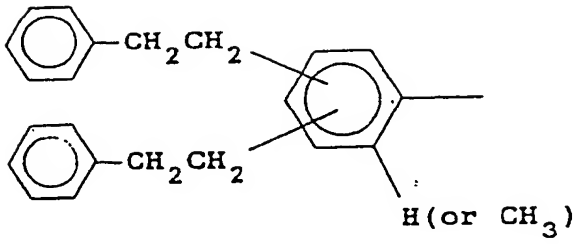
(II)

wherein X, Y and Z, which may be the same or different are each hydrogen, chlorine, lower alkyl or the group of $-COOR_4$, -COOH, $-CH_2COOH$ or $-CH_2COOR_4$, in which R_4 is alkyl of 1-4 carbon atoms.

5. The adhesive sheet as claimed in claim 4 wherein the nonionic surface active agents are

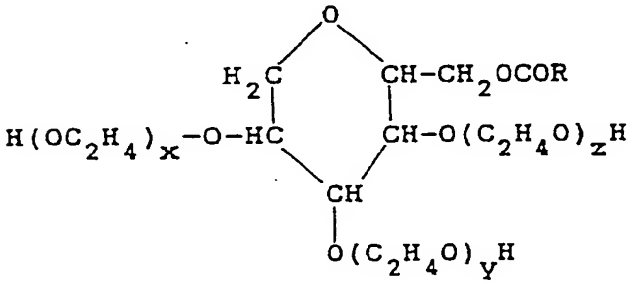
(i) $OH(C_2H_4O)_a(C_3H_6O)_b(C_2H_4O)_cH$ wherein a, b and c are each an integer of 20-80,

(ii) $RA(C_2H_4O)_eH$ wherein R is alkyl of 6-18 carbon atoms, alkylphenyl having alkyl of 4-20 carbon atoms or the group



A is oxygen, sulfur or the group of -COO, -CONH, $CON(C_2H_4O)_eH$, PO_4H or $PO_4(C_2H_4O)_eH$, the symbols e, which may be the same or different, each represent an integer of 2-80, or

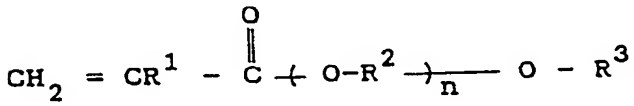
(iii)



wherein R is alkyl of 6-18 carbon atoms, and x, y and z are each an integer of 2-40.

6. The adhesive sheet as claimed in claim 1 wherein the water-swelling adhesive comprises (A) a water-soluble polymer and (B) a (meth)acrylic ester mononer which gives a water-swelling polymer.

7. The adhesive sheet as claimed in claim 1 wherein (A) the water-soluble polymer is derived from a (meth)acrylic ester monomer represented by the formula



wherein R^1 is hydrogen or methyl, R^2 is alkylene 2-4 carbon atoms, R^3 is alkyl of 1 or more carbon atoms, and n is an integer of 1 or more, (meth)acrylic acid, (meth)acrylic ester, vinylpyrrolidone, acrylamide, dimethylaminoethyl(meth)acrylate, diethylaminoethyl (meth)acrylate, or vinyl methyl ether.

8. The adhesive sheet as claimed in claim 7 wherein (B) the (meth)acrylic ester monomer is (meth)acrylic ester monomers, dimethylaminoethyl(meth)acrylates or diethylaminoethyl(meth)acrylates, (meth)acrylate.

9. The adhesive sheet as claimed in claim 1 wherein the water-swelling adhesive comprises (A) a salt of a copolymer obtained by neutralizing the carboxyl group in a copolymer comprising 10-40 mol% of a carboxyl-containing monomer, 60-90 mol% of (meth)acrylic alkyl ester having alkyl of 4 or more carbon atoms and 0-20 mol% of vinyl monomer other than the above-mentioned monomers and (B) a hydrophilic compound represented by the formula $R_1O(R_2O)_nR_3$ wherein R_1 is alkyl of 1-4 carbon atoms, R_2 is alkylene of 2-4 carbon atoms, R_3 is hydrogen, alkyl of 1-4 carbon atoms or acetyl, and n is an integer of 1-6.

10. Use of an adhesive sheet as defined in any preceding claim to protect the patterned face of a semiconductor wafer while the back of said wafer is subjected to grinding with water washing.

FIG.1

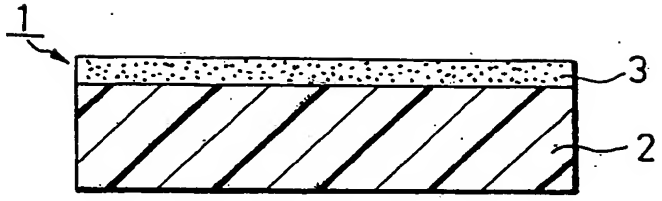


FIG.2

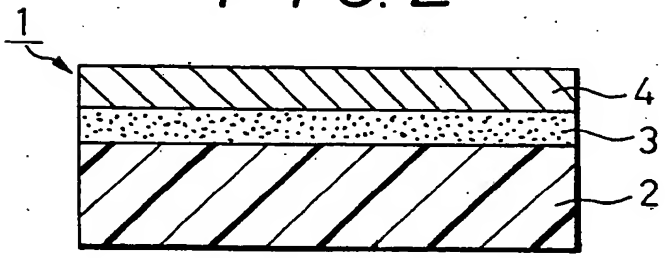


FIG.3

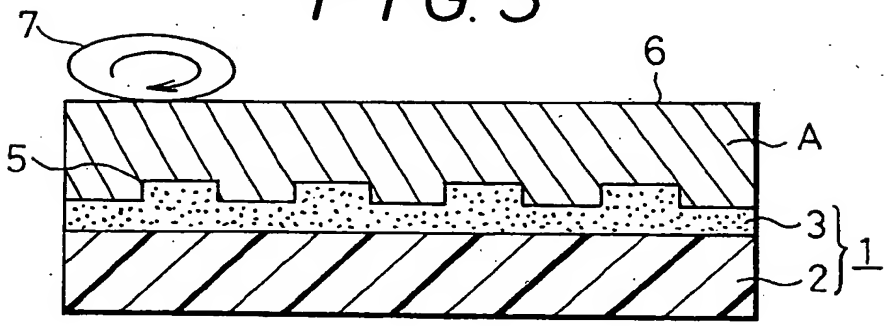
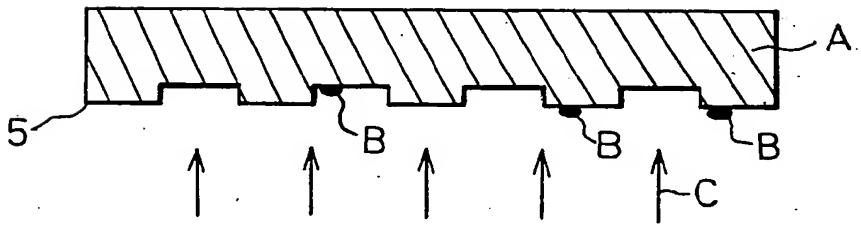


FIG.4



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(11) Publication number: **0 252 739**
A3

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 87306075.0

(51) Int. Cl.⁴: H01L 21/68

(22) Date of filing: 09.07.87

(30) Priority: 09.07.86 JP 161682/86
26.02.87 JP 43744/87

(43) Date of publication of application:
13.01.88 Bulletin 88/02

(84) Designated Contracting States:
DE FR GB NL

(88) Date of deferred publication of the search report:
05.04.89 Bulletin 89/14

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(54) **Adhesive sheets for sticking wafers thereto.**

(57) according to the present invention are adhesive sheets which are applied to the face side of wafers having formed patterns thereon when the reverse side of said wafers are subjected to grinding treatment, characterized in that the adhesive sheets comprise a base and a water-swelling adhesive coated thereon as an adhesive layer.

EP 0 252 739 A3

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EUROPEAN SEARCH REPORT

Application Number

EP 87 30 6075

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	EP-A-0 150 882 (STAUFFER) * Claims 1-3; page 3, lines 11-15; page 4, line 30 - page 5, line 4 *	1	H 01 L 21/68
A		2,4	
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A	EP-A-0 134 606 (STAUFFER)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26-01-1989	DE RAEVE R.A.L.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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